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RESEARCH ARTICLE

UPPER CRETACEOUS-OLIGOCENE TETHYAN AGGLUTINATED BENTHIC FORAMINIFERAL SPECIES OF THE GENUS *ARENOBULIMINA*

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ABSTRACT

The agglutinated test of the genus *Arenobulimina* has trochospirally enrolled, four or more chambers per whorl, aperture interiomarginal with a simple arch or loop, which has a comprising various species. Seven small Upper Cretaceous-Oligocene benthic foraminiferal species of this agglutinated genus *Arenobulimina* are common in some Tethyan localities: North Atlantic (USA, Trinidad, Labrador Sea), Europe (Spain, France, Germany, Czech, Poland, Sweden), Northeast Africa (Egypt), and Southwest Asia (Palestine, UAE). These species are: Upper Cretaceous *A. americana* Cushman, Late Maastrichtian *A. beitjebrinensis* Anan and *A. jerusalemensis* Anan, Upper Cretaceous-Paleocene *A. truncata* (Reuss), Paleocene *Arenobulimina aegyptiaca* (Said & Kenawy) and Paleocene-Eocene *A. dorbignyi* (Reuss). One Early Eocene - Early-Oligocene species *Arenobulimina kaminskii* is believed here to be new species.

KEYWORDS

Palaeontology, stratigraphy, paleogeography, benthic foraminifera, *Arenobulimina,* Tethys

1. INTRODUCTION

The genus *Arenobulimina* has received much attention from many authors, e.g. (Reuss, 1845 (Germany); Cushman, 1936 (USA); Said & Kenawy, 1956 (Egypt); Gawor-Biedowa, 1969 (Poland), Price, 1977 (NW Europe); Anan, 2022 (Palestine). This study deals with some other Upper Cretaceous-Early Oligocene species of *Arenobulimina* in the Tethys, which have wide geographic distributed in North America, West Europe, North Africa, and SW Asia (Figure 1). Evolutionary changes of the identified species are indicated by such criteria, such as changes in the test-size, chambers arrangement, type of sutures, periphery or surface ornamentation. These changes help to define the major faunal change through the Maastrichtian-Oligocene times, and can be used in the biostratigraphic subdivisions and paleogeographic and environmental correlations.

Figure 1: Location map of the members of the genus *Arenobulimina* in the Northern Tethys (Spain, France, Germany, Poland, Czech, Sweden) and Southern Tethys (Egypt, Palestine, UAE).

2. MATERIAL AND METHOD

Seven small Upper Cretaceous-Oligocene benthic foraminiferal species of the agglutinated genus *Arenobulimina* are recorded from many localities in the Northern and Southern Tethys. The present study aims at throwing light on: 1) present together many data scattered in the literature for this genus under a unifying theme, 2) detect its paleontology, stratigraphy and paleogeographic distribution of the different species of that genus, and 3) present a new species *Arenobulimina kaminskii*.

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3. TAXONOMY

The members of the genus *Arenobulimina* are characterized by its trochospirally enrolled agglutinated test, four or more chambers per whorl, a simple arch or loop interiomarginal aperture, but without apertural tooth. The taxonomy of Kaminski is followed in this study for diagnostic seven agglutinated foraminiferal benthic specie were erected from six countries in the Tethys (Kaminski, 2014). The new taxonomic considerations are used for many recorded species. These species are illustrated in Plate 1.

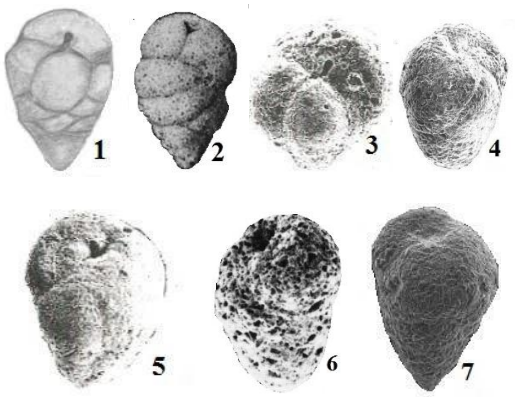

Plate 1: Figure 1. Arenobulimina aegyptiaca Said & Kenawy (1956) x 30, 2. A. americana Cushman (1936) x 45, 3. A. beitjebrinensis Anan (2022) x 35, 4. A. dorbignyi (Reuss, 1845), x 65, 5. A. jerusalemensis Anan (2022), x 35, 6. A. kaminskii Anan, n. sp. x 70, 7. A. truncata (Reuss, 1845) x 20.

Order Loftusiida Kaminski & Mikhalevich, 2004

Suborder Ataxophragmiina Fursenko, 1958

Genus *Arenobulimina* Cushman, 1927

***Arenobulimina aegyptiaca* Said & Kenawy, 1956**, p. 126, pl. 1, fig. 42☻ {illustrated specimen} (Plate 1, figure 1)

Remarks: This Paleocene species is characterized by its smooth conical test, tapering at the base, and greatest breadth at the apertural end, aperture a narrow loop-shaped opening at the base of the apertural face. It was recorded from the Paleocene of Sinai (Egypt), and Jabal Malaqet (UAE) (see Figure 1).

***Arenobulimina americana* Cushman, 1936**, p. 27, pl. 4, fig. 9☻ (Plate 1, figure 2)

Remarks: This Upper Cretaceous species differs from the Paleocene *A. aegyptiaca* by its finely wall arenaceous rather smoothly finished test, and small loop-shaped aperture. It was recorded, so far from USA, Mexico, Brazil and Argentina (Figure 2).

Figure 2: Location map of USA and Mexico (North America) and Brazil and Argentina (South America).

***Arenobulimina beitjebrinensis* Anan, 2022,** p. 27, pl. 1, fig. 58; pl. 2, fig. 3 (=*Arenobulimina* sp. A. Almogi-Labin et al., 1990, p. 578, pl. 2, fig. 5 (Plate 1, figure 3)

Remarks: This Late Maastrichtian species differs from the other members of the genus *Arenobulimina* by its more tapering initial part and more inflated last chambers in the last whorl. It is recorded, so far, from Palestine (Figure 3).

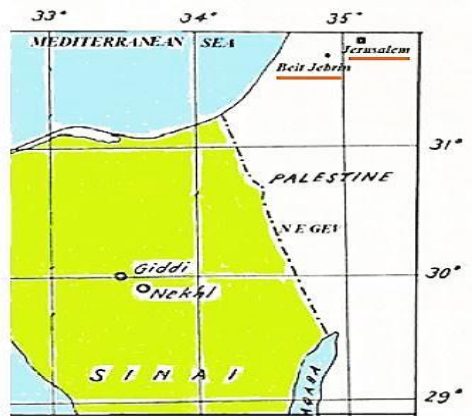

Figure 3: Location map of the two studied sections in Palestine (Jerusalem and Beit Jebrin), as well as Giddi and Nekhl sections, Sinai of Egypt (after Said & Kenawy, 1956).

***Arenobulimina dorbignyi* (Reuss, 1845)** (=*Bulimina dorbignyi* Reuss, 1845, p. 38, pl. 13, fig. 74; Sztrákos, 2005, p. 184, pl. 2, fig. 6)☻ (Plate 1, figure 4)

Remarks: This Paleocene-Eocene species differs from the previous species by its rounded initial part and finely-medium agglutinated grains of the test. It is recorded from Trinidad, Sweden, France, Czech, Poland (see Figure 1).

***Arenobulimina jerusalemensis* Anan, 2022,** p. 26, pl. 1, fig. 59, pl. 2, fig. 4. **(**=*Arenobulimina* sp. B. Almogi-Labin et al., 1990, p. 578, pl. 2, fig. 4)☻ (Plate 1, figure 5)

Remarks: This Late Maastrichtian species differs from *A. beitjebrinensis* in its shorter length test. It is recorded, so far, from Palestine.

***Arenobulimina kaminskii* Anan, n. sp.** (=*Arenobulimina* sp. Kaminski et al., 1989, p. 730, pl. 6, fig. 4)☻(Plate 1, figure 6)

Holotype: Illustrated specimen in Plate 1, figure 6.

Diameter: Length 0.25 mm, width 0.20 mm.

Etymology: After Prof. M. Kaminski, King Fahd University of Petroleum and Minerals, Saudi Arabia.

Type locality: Southern Labrador Sea (Figure 4).

Stratigraphic level: Early Eocene-Early Oligocene.

Diagnosis: This long ranged species has trochospirally enrolled test, coarsely agglutinated wall, distinct inflated chambers, sutures slightly depressed, aperture an interiomarginal highly open looped on the apertural face, and without lip or apertural tooth.

Remarks: This new species differs from other recorded species of *Arenobulimina* in its coarsely arenaceous wall, highly and wide opening aperture on the apertural face.

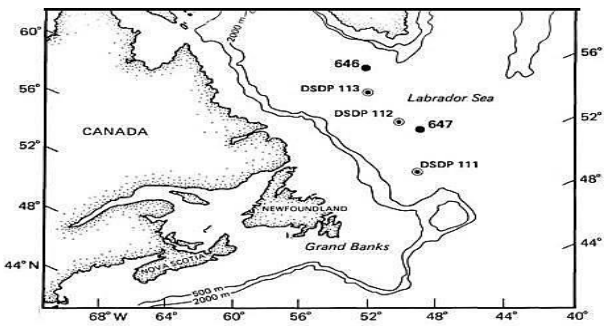

Figure 4: Location map of the studied wells in the Labrador Sea, North Atlantic Ocean.

***Arenobulimina truncata* (Reuss, 1845)(**=*Bulimina (pasternakia) truncata* Reuss, 1845, p. 38, pl. 8, fig. 73) (Plate 1, figure 7)

Remarks: The Upper Cretaceous-Paleocene species distinguished by its tapering initial part with acute angle to the axis of coiling. It has a wide geographic distribution in North America (USA, Mexico, Trinidad) and Europe (Spain, Germany, Czech).

4. Stratigraphic Value of the Seven Benthic Foraminiferal Species of *Arenobulimina*

Seven species have wide stratigraphic time from the Upper Cretaceous to Early Oligocene and recorded from many parts of the Tethys: North America to southwest Asia via Europe and north Africa. The stratigraphic value of these taxa are arranged from descending order (older to younger): Upper Cretaceous *Arenobulimina americana* Cushman, Late Maastrichtian *A. beitjebrinensis* and *A. jerusalemensis* both of Anan, Upper Cretaceous-Paleocene *A. truncata* (Reuss), Paleocene *A. aegyptiaca* Said & Kenawy, Paleocene-Eocene *A. dorbignyi* (Reuss) and Early Eocene-Early Oligocene *A. kaminskii* n. sp. The Upper Cretaceous and Paleocene fauna (*A. americana*, *beitjebrinensis, A. jerusalemensis*, *A. truncata* and *A. aegyptiaca*) have mainly a tapering initial part with acute angle to the axis of coiling, and fine to medium-grained agglutinated wall, while the post Paleocene to Oligocene species (*A. dorbignyi* and *A. kaminskii*) have rounded initial part, and coarse-grained agglutinated wall (Figure 5).

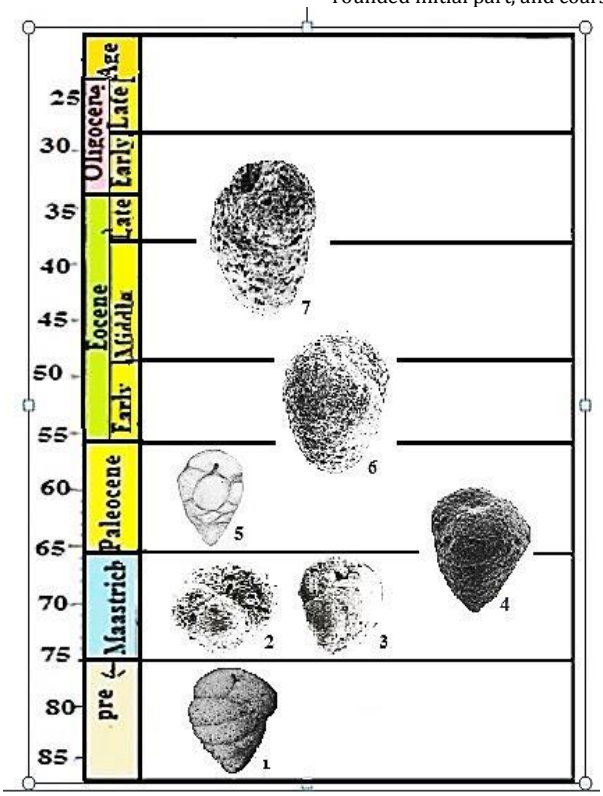

Figure 5: The stratigraphic levels of the identified Pre-Maastrichtian-Oligocene species of the genus *Arenobulimina* from the different localities in the Tethys: **1**. *Arenobulimina americana* Cushman, **2**. *A. beitjebrinensis* Anan, **3**. *A. jerusalemensis* Anan, **4**. *A. truncata* (Reuss), **5**. *A. aegyptiaca* Said & Kenawy, **6**. *A. dorbignyi* (Reuss), **7**. *A. kaminskii* n. sp

5. Paleogeography

The Tethys had been connected from west Atlantic Ocean to east with the Pacific Ocean via the Mediterranean Sea during the Cretaceous-Paleogene time. The identified seven species have wide stratigraphic time from the Upper Cretaceous to Early Oligocene and recorded from many parts of the Tethys: North America (USA, Mexico, Trinidad), South America (Brazil, Argentina), Europe (Spain, Germany, Czech), North Africa (Egypt) and southwest Asia (Palestine, UAE) (Figure 6).

Figure 6: The paleogeographic map at K/T boundary showing the connected seas from west (USA, Atlantic Ocean, Brazil, Argentina) to east (Indian and Pacific Oceans) via the Mediterranean Sea, as well as the locations of the Northern Tethys localities (Spain, France, Germany) and Southern Tethys localities (Egypt, Palestine, UAE) (after Solakius et al., 1990).

According to many authors (e.g. Anan, 1995; Haq and Aubry, 1978; Rosenbaum et al., 2002, Finger, 2013; Anan, 2022). The wide geographic distribution of the identified species proved that the Tethyan realm had been connected with the Atlantic Ocean from west to the Indo-Pacific Ocean to the east, via Mediterranean Sea, crossing the Middle East region during the Paleogene time.

Table (1) shows the paleogeographic distribution of the identified seven agglutinated benthic foraminiferal species in the Upper Cretaceous-Early Oligocene. Some remarks are presented:

1. *Arenobulimina dorbignyi* has wide geographic distribution, which were recorded from five countries: Trinidad, Sweden, France, Czech and Poland.
2. *A. truncata* has also wide geographic distribution: USA, Mexico, Spain, Czech.
3. *A. americana* also has wide geographic distribution: USA, Mexico. Chile and Argentina.
4. *A. aegyptiaca* was recorded from two countries: Egypt and UAE.
5. The other three species of *Arenobulimina* was confined to their original type localities: Palestine (*A. beitjebrinensis*, *A. jerusalemensis*), and Labrador Sea (*A. kaminskii*).
6. Regardless of unrealized synonymies, this clearly indicates that many species did not have wide geographic or temporal ranges.

Table 1: Paleogeographic distribution of the seven agglutinated benthic foraminifera species of the genus *Arenobulimina* in some Tethyan localities: 1. USA, 2. Mexico, 3. Trinidad, 4. Brazil, 5. Argentina, 6. Labrador Sea, 7 Sweden, 8. Spain, 9. France, 10. Czech, 11. Poland, 12. Egypt, 13. Palestine, 14. UAE (Sp. No. = Species number, x=recorded, - not recorded).

Sp. No.	countries / species		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	*Arenobulimina*	*aegyptiaca*	-	-	-	-	-	-	-	-	-	-	-	x	-	x
2		*americana*	x	x	-	x	x	-	-	-	-	-	-	-	-	-
3		*beitjebrinensis*	-	-	-	-	-	-	-	-	-	-	-	-	x	-
4		*dorbignyi*	-	-	x	-	-	-	x	x	x	x	-	-	-	-
5		*jerusalemensis*	-	-	-	-	-	-	-		-	-	-	-	x	-
6		*kaminskii*	-	-	-	-	-	x	-	-	-	-	-	-	-	-
7		*truncata*	x	x	-	-	x	-	-	x	-	x	-	-	-	-

6. Paleoenvironment

The identified members of the genus *Arenobulimina* includes finely wall arenaceous smoothly finished and also coarsely agglutinated wall tests. According to different authors, the smaller agglutinating foraminifera occur in all marine environments, from marginal to deep, and some are tolerant of hyposalinity as well as normal marine salinity, and/or of hypoxia or dysoxia (e.g. Kaminski et al, 1989; Cetean et al, 2011). Increasingly poorer preservation of agglutinated foraminifers reflects the first appearance of cool, nutrient-poor deep water. During the sea-level maxima calcareous-cemented species such as *Clavulinoides, Dorothia, Marssonella, Arenobulimina*, and *Gaudryina* increase in number, becoming almost equal in numbers with the tubular forms.

7. Conclusions

The present study deals with the recording of seven identified species of the agglutinated foraminifera genus *Arenobulimina* in fifteen localities of the Tethys: North America (USA, Mexico, Trinidad, Labrador Sea), South America (Brazil, Argentina), Europe (Spain, France, Germany, Sweden, Poland, Czech), Southern Tethys (Egypt, Palestine and UAE). The Tethyan realm had been connected with the Atlantic Ocean from west to the Indo-Pacific Ocean to the east, via Mediterranean Sea, crossing the Middle East region during the Maastrichtian-Paleogene time. Evolutionary changes of the identified species are presented and these changes help to define the major faunal change through the Maastrichtian-Oligocene times, and can be used in the biostratigraphic subdivisions and environmental conditions.

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